A new species of the genus *Quasipaa* (Anura, Ranidae, Dicroglossinae) from northern Vietnam

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A new species of the genus *Quasipaa* from northern Vietnam is described and compared with four related species from China: *Quasipaa spinosa*, *Q. jiulongensis*, *Q. exilispinosa* and *Q. courtoisi*, the latter being here confirmed, on morphometric grounds, as a distinct species. *Q. courtoisi* differs from the four other species by measurements concerning the hands, feet and head. The new species is further distinguished from *Q. exilispinosa* by its larger webbing. It is a sibling species of *Q. spinosa* from which it differs by a higher number of nuptial spines on the prepollex and finger I of breading males.

INTRODUCTION

During his travels of exploration of the Chinese Empire, the father Armand David discovered a large frog living in torrents of the mountains in the surroundings of Jinjiang (Jiangxi Sheng), the breeding males of which emit a strong and loud call and have the chest and fingers covered with black horny spines. He described it as new on two occasions, first (DAVID, 1872: 76) as *Rana latrans*, a nomen which later proved invalid, being a junior primary homonym, and later (DAVID, 1875: 253) as *Rana spinosa*. This species is still known under the latter specific nomen, but it is now referred to the genus *Quasipaa* Dubois, 1992 (Ranidae, Dicroglossinae, Paini; see JIANG et al., 2005; OHLER & DUBOIS, 2006, FROST et al., 2006; CHI et al., 2009).

Although many nomina have been proposed in the literature for species of the genus *Quasipaa*, OHLER & DUBOIS (2006) only recognized 11 valid species in this genus. Among these, two informal groups can be distinguished by the aspect of their warts on the mid-dorsal skin: a group of seven species with longitudinally elongate, regularly arranged warts, some of which are quite wide and prominent, and a group of four species with smaller warts, not very prominent, rounded or slightly elongate, or if elongate not wide and regularly arranged on

back. The latter group can be provisionally designated as "*Quasipaa* sensu stricto", as it includes *Rana spinosa*, the type-species of *Quasipaa*, whereas for the former group the generic nomen *Eripaa* Dubois, 1992 (type-species *Rana fasciculispina* Inger, 1970) would be available if it proved holophyletic and had to be recognized formally as a subgenus. The four species of "*Quasipaa* sensu stricto" recognized by Ohler & Dubois (2006) include three species recognized by all recent authors (e.g., Fei, 1999; Fei et al., 2006; Che et al., 2009), i.e., *Quasipaa exilispinosa* (Liu & Hu, 1975), *Quasipaa jiulongensis* (Huang & Liu, 1985) and *Quasipaa spinosa* (David, 1875), and a species, *Quasipaa courtoisi* (Angel, 1922), usually considered as a synonym of the latter. Recent molecular data (Che et al., 2009) suggest that additional species probably require recognition in this group.

Most species of *Quasipaa* are endemic to China, but a few of them occur in the eastern part of the Indochinese peninsula (Cambodia, Laos, Thailand and Vietnam). One of them was reported under the nomen *Rana spinosa spinosa* by Bourret (1937, 1942) on the basis of 14 adult specimens collected by him on the Mau Son (then spelt Mao-Son) in northern Vietnam. Six of these specimens (5 males, 1 female) are still kept in the collections of the Paris Museum under the numbers MNHN 1938.0001-0006. A seventh specimen from the same series was transferred to the Edward H. Taylor collection and later to the Field Museum in Chicago, where it is still kept under the number FMNH 123883 (Alan Resetar, personal communication). Two additional specimens of the same species from Mau Son are known to exist in collections. The first additional one was collected in 1903 by H. Fruhstorfer between 915 and 1220 m (3000-4000 ft) in the Mau Son, along with several other frog species (Boulenger, 1903; Bourret, 1942: 13). It was identified as *Rana spinosa* by Boulenger (1920: 75). It is still kept in the Natural History Museum collection in London under the number BMNH 1903.7.2.26. Finally, a second additional specimen was part of the collection of herpetological specimens made by J. Delacour and W. P. Lowe in Tonkin and Annam in 1926 and 1927: this specimen, stated to be from Lang Son, is also probably from Mau Son (Bourret, 1942: 291). It was identified by H. W. Parker as *Rana duboisreymondi* and reported under this nomen by Angel (1928). It is still present in the Paris Museum collection under the number MNHN 1928.0025.

Although by their overall aspect these Mau Son specimens indeed resemble Chinese specimens of *Quasipaa spinosa*, they differ from them in a few respects, as discussed below. We used morphometric data to compare them with numerous Chinese specimens referred to the four species of "*Quasipaa* sensu stricto". This analysis revealed constant and significant differences between the Vietnamese specimens and all Chinese specimens, and we consider that they demonstrate the existence of a distinct species in Vietnam, which is described and named here.

Material and methods

Appendix 1 provides a list of the specimens of "*Quasipaa* sensu stricto" examined and measured for this study, along with the abbreviations used to designate the collections where they are kept. Specimens were sexed using their external characters (in the case of adult breeding males) or through a slight lateral incision in order to see one of the gonad. All

specimens examined in this study were adult, according to the criteria of DUBOIS (1976: 31-33).

Appendix 2 provides a list and descriptions of the measurements taken on these specimens. Measurements were obtained with a slide calliper to the nearest 0.1 mm, or, for values below 5 mm, with an ocular micrometer to the nearest 0.01 mm. For univariate comparisons between samples, all measurements except snout-vent length (SVL) were transformed in ratio to SVL, expressed in per thousands (‰). Subgroups were composed according to two possible criteria: taxonomic allocation and sex.

Univariate morphometric comparisons between samples were made using the non-parametric Mann-Whitney *U* test (ZAR, 1984). Multivariate factor analyses were performed using the Principal Component Analysis (PCA) with varimax rotation as implemented in the software SPSS (ANONYMOUS, 1999. 426). According to the Kaiser criterion, eigenfactors larger than 1 where retained (NORUSIS, 1992) Factors of PCA were plotted as scatterplots indicating species allocation. To examine effects of species delimitation on the principal component scores, factorial ANOVA were performed Calculations and statistical analyses were realised using SPSS statistical software (NORUSIS, 1992)

The holophoront (holotype) of the new species was described in detail using the same format and methodology as in several of our previous works on Asian anurans, in particular ranids (OHLER & DUBOIS, 1999; DUBOIS & OHLER, 2000, 2001, 2005; DUBOIS et al., 2001, VEITH et al , 2001; OHLER et al., 2002) Some of the terms used below (holophoront, hypodigm, onymotope) were defined elsewhere, and reasons were provided for using them (DUBOIS, 2000, 2005). The traditional terms of equivalent meaning are indicated below on first use between parentheses.

TAXONOMY

Quasipaa acanthophora sp. nov
(fig. 1)

Etymology of specific nomen. From the Greek ακανθος, "spine" and φερω , "I bear" This nomen is the Greek equivalent of *spinosa* in Latin.

Holophoront (holotype) MNHN 1938.0001 (ex LZUH Z.108), adult male, SVL 101 7 mm.

Onymotope (type locality) – Mau Son (21°51'N, 106°58'E), Lang Son province, Vietnam.

Other specimens of the hypodigm (paratypes). MNHN 1938.0002 (ex LZUH Z 107), 1938 0003 (ex LZUH Z.106), 1938 0004 (ex LZUH Z.115) and 1938.0006 (ex LZUH Z 109), and FMNH 123883 (ex LZUH Z.112), 5 ♂, SVL 83.0-99 5 mm; and MNHN 1938 0005 (ex LZUH Z.113), 1 ♀, SVL 81.0 mm; all collected by René Bourret in the same locality as the holophoront. MNHN 1928.0025, 1 ♂, SVL 79 0 mm, collected in 1926 or 1927 by Jean Delacour and Willoughby Prescott Lowe in the same region. BMNH 1903.7.2.26, 1 young ♂, SVL 61.3 mm, collected in 1903 by Hans Frühstorfer on the same mountain. Seven additional

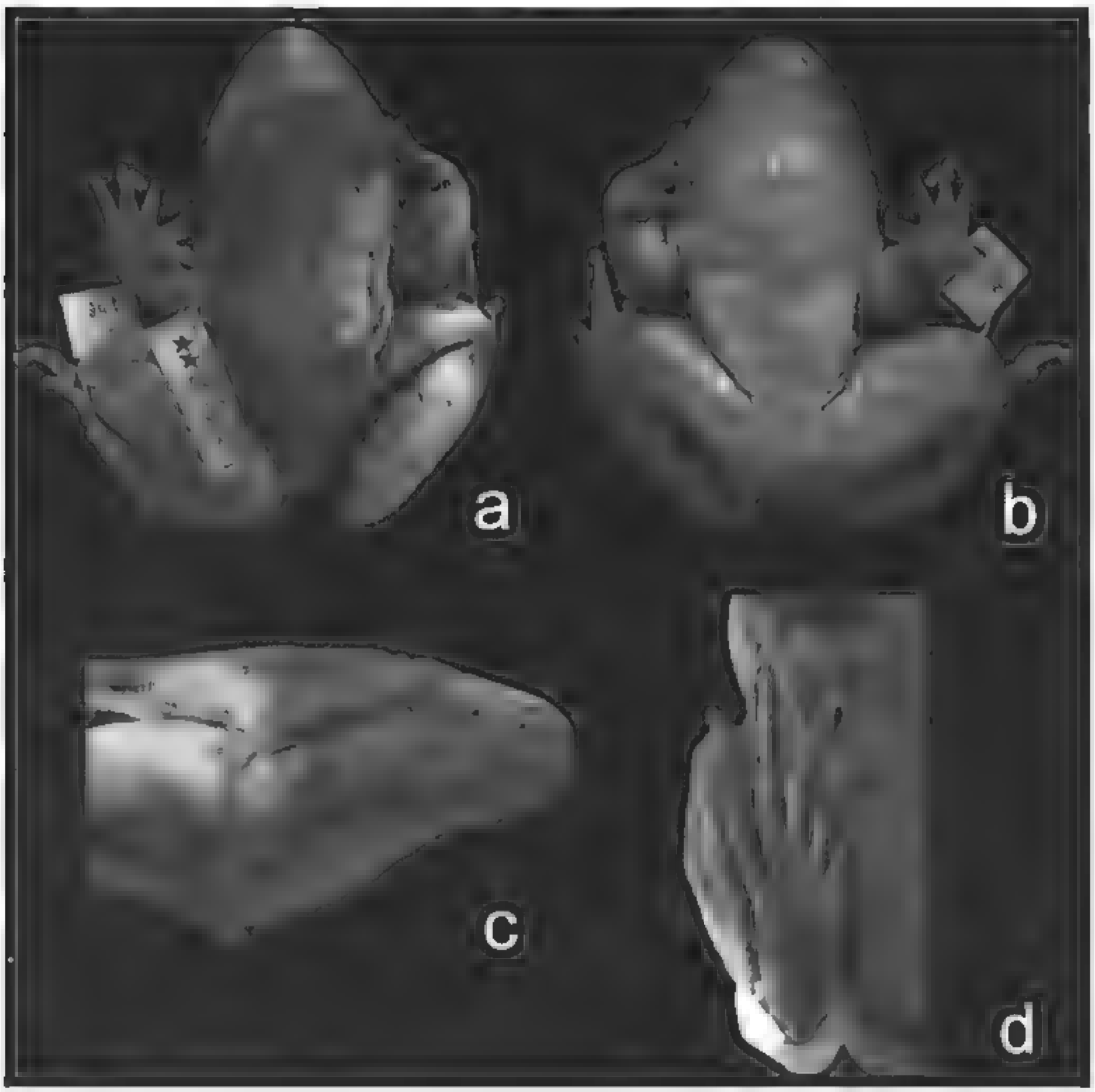

Fig 1 *Quasipaa acanthophora* sp. nov., holophoront MNHN 1938.0001, adult male, SVL 101.7 mm (a) Dorsal view, (b) ventral view; (c) right lateral view of head; (d) ventral view of right foot

specimens (LZUH B 103-105, B.107, Z.110-111, Z.116) were reported by Bourret (1942: 26) from the same locality and probably belonged in the same species. We have been unable until now to locate any of them in current collections, but some might be rediscovered in the future However, because we have been unable to examine them, we refrain to formally designate them as paratypes of the new species.

Description of the holophoront (A) Size and general aspect. – (1) Specimen of large size (SVL 101.7 mm), body rather stout.

(B) Head (2) Head rather large, wider (HW 41.0 mm) than long (HL 38.5 mm; MN 32.2 mm; MFE 25.1 mm, MBE 17.2 mm), flat above. (3) Snout rounded, slightly protruding,

its length (SL 14.4 mm) longer than horizontal diameter of eye (EL 11.2 mm). (4) Canthus rostralis indistinct, loreal region concave, flared in cross section (5) Interorbital space flat, smaller (IUE 8.1 mm) than upper eyelid (UEW 9.0 mm) and internarial distance (IN 10 0 mm); distance between front of eyes (IFE 15.3 mm) about three fifth of distance between back of eyes (IBE 26 8 mm). (6) Nostrils oval, with flap of skin laterally, closer to eye (EN 6 8 mm) than to tip of snout (NS 7.8 mm). (7) Pupil indistinct (8) Tympanum indistinct (9) Pineal ocellus present, between anterior borders of eyes. (10) Vomerine ridges present, bearing numerous small teeth ($n = 10$), between choanae, with an angle of 60° relative to body axis, as close to choanae as to each other, longer than distance between them. (11) Tongue large, cordate, emarginated, median lingual process absent; tooth like projection on maxilla absent.

(C) Forelimbs. (12) Arm rather short (FLL 25.9 mm), strong, shorter than hand (HAL 25.2 mm), distinctly enlarged. (13) Finger I rather long and strong; finger II rather short, rather strong; finger III rather long and strong (TFL 12 8 mm); finger IV short, relatively thin. (14) Relative length of fingers, shortest to longest: II < I < IV < III (15) Tips of fingers rounded, slightly enlarged, without discs. (16) Fingers II and III with dermal fringes; webbing absent (17) Subarticular tubercles prominent, rounded, single, all present. (18) Prepollex oval, prominent, two oval, distinct palmar tubercles; supernumerary tubercles absent.

(D) Hindlimbs. – (19) Shank three times longer (TL 53 5 mm) than wide (TW 18 8 mm), about as long as thigh (FL 52.8 mm) and distance from base of internal metatarsal tubercle to tip of toe IV (FOL 52 2 mm). (20) Toes rather short and thin; toe IV (FTL 28.9 mm) more than one third of distance from base of tarsus to tip of toe IV (TFOL 72.1 mm). (21) Relative length of toes, shortest to longest: I < II < V < III < IV. (22) Tips of toes rounded, distinctly enlarged, without discs. (23) Webbing complete: I 0–0 II 0–0 III 0 0 IV 0 0 V (WTF 16.1 mm; WFF 14.5 mm, WI 14.4 mm, WII 11 6 mm). (24) Dermal fringe along toe V well developed, from tip of toe to basis of metatarsus. (25) Subarticular tubercles very prominent, oval, simple, all present (26) Inner metatarsal tubercle long, prominent; its length (IMT 8 3 mm) 1 7 times in length of toe I (ITL 14.2 mm). (27) Tarsal ridge present, two thirds of distal parts of tarsus. (28) Outer metatarsal tubercle, supernumerary tubercles and tarsal tubercle absent

(E) Skin (29) Dorsal and lateral parts of head and dorsal part of back shagreened with regularly disposed glandular warts on back; upper part of flanks shagreened with elongated glandular warts, lower part of flanks with foldings. (30) Dorsolateral folds absent; lateral line system absent; "fejervaryan line" absent; supratympanic fold prominent, from eye to above arm; cephalic ridges absent; co-ossified skin absent. (31) Dorsal parts of limbs: forelimbs shagreened; thigh shagreened with thin foldings, legs shagreened with thin foldings and horny spinules; tarsus smooth. (32) Ventral parts of head, chest and Limbs smooth; belly with transversal foldings. (33) No macroglands.

(F) Coloration in alcohol. – (34) Dorsal and lateral parts of head and body: dorsum brown with dark brown spots around the warts; a dark brown band across upper eyelids and head; upper part of snout clearer, light brown; upper part of flank like back; lower part of flank brown with light marbling; loreal region light brown with dark brown bands, tympanic region light brown with a dark brown band underlining tympanic fold, upper lip light brown with three distinct vertical dark brown bars. (35) Dorsal parts of limbs: forelimbs, dorsal part of thigh, leg and foot brown with indistinct darker bands; posterior part of thigh dark brown

Table 1. Maximum numbers of nuptial spines in breeding males of *Quasipaa courtoisi*, *Q. exilispinosa*, *Q. jiulongensis*, *Q. spinosa* and *Q. acanthophora*. The table gives the total number of spines on breast and the maximum numbers of spines observed on one arm (either left or right) in a given place (ppxmax, prepollex, imax, finger I, umax, finger II, tmax, finger III). Number of specimens observed is given in brackets. For *Q. spinosa* only males of size interval corresponding to adult size in *Q. acanthophora* were included in the analysis. The Mann-Whitney *U* test compares the spine numbers of *Q. spinosa* and *Q. acanthophora*. Significance level ***, $P < 0.001$, **, $P < 0.01$

Spine number	*Q. courtoisi*	*Q. exilispinosa*	*Q. jiulongensis*	*Q. spinosa*	*Q. acanthophora*	Mann-Whitney *U*-test
breast	153.3 ± 37.2 (7) 87-195	81.6 ± 60.7 (12) 0-198	106.9 ± 63.2 (27) 0-288	130.8 ± 27.0 (14) 88-171	139.5 ± 145.9 (6) 0-322	$U = 39$ $P = 0.841$ n.s.
ppxmax	17.7 ± 10.8 (6) 7-38	9.4 ± 5.2 (12) 2-17	11.3 ± 10.7 (27) 2-56	13.8 ± 5.6 (14) 2-22	30.5 ± 14.1 (6) 19-55	$U = 7$ $P = 0.002$ **
imax	159 (1)	28 ± 9.3 (12) 13-42	39.9 ± 21.5 (27) 22-128	67.9 ± 15.0 (14) 48-91	115.2 ± 23.8 (6) 96-162	$U = 0$ $P = 0.000$ ***
rmax	27.6 ± 15.3 (5) 0-51	9 ± 6.3 (12) 0-19	15.9 ± 8.2 (27) 4-45	23.4 ± 6.7 (14) 13-34	35.8 ± 15.6 (6) 23-59	(19.5 $P = 0.062$ n.s.
umax	11.3 ± 10.4 (4) 3-26	1.7 ± 2.5 (12) 0-7	4 ± 4.6 (27) 0-14	7.9 ± 5.7 (14) 1-17	15.5 ± 15.6 (6) 4-38	$U = 32.5$ $P = 0.444$ n.s.

Table 2. – Snout-vent length and ratio of SVL to body measurements for adult males and female of *Quasipaa acanthophora*

Measurements	Males *n* = 6	Female *n* = 1	Measurements	Males *n* = 6	Female *n* = 1	Measurements	Males *n* = 6	Female *n* = 1
SVL	92.1 ± 9.18 79-101.7	81.0	IN/SVL	96 ± 1.88 94-98	94	FTL/SVL	288 ± 10.27 274-302	288
HW/SVL	410 ± 31.25 398-430	395	EN/SVL	60 ± 4.7 53-67	60	IMT/SVL	83 ± 3.64 77-87	77
HL/SVL	382 ± 3.18 379-387	383	EL/SVL	115 ± 4.77 108-119	112	ITL/SVL	136 ± 7.75 121-141	144
MN/SVL	320 ± 8.76 309-334	321	FLL/SVL	252 ± 17.66 230-273	256	WTF/SVL	162 ± 5.93 157-172	159
MFE/SVL	263 ± 12.86 247-280	259	HAL/SVL	238 ± 10.4 220-248	242	WFF/SVL	143 ± 6.5 134-151	144
MBE/SVL	165 ± 10.66 144-175	170	TFL/SVL	125 ± 2.77 120-128	127	WF/SVL	148 ± 5.68 142-157	152
IFE/SVL	153 ± 7.24 141-163	148	TL/SVL	531 ± 14.07 513-554	543	WH/SVL	117 ± 7.5 106-129	127
IBE/SVL	268 ± 11.13 255-288	257	FOL/SVL	523 ± 17.29 503-541	535			

with light brown flecks. (36) Ventral parts: throat and chest brown with whitish marblings; margin of throat whitish with brown spots; belly dirty whitish; thigh dirty white with brown marbling on sides; webbing brown.

(G) Male secondary sex characters. - (37) Large-sized, black nuptial spines present on prepollex and finger I (two separate pads), fingers II and III and chest. Table 1 gives the numbers of spines in these places on both hands. (38) Forearms enlarged. (39) Vocal sacs indistinct on throat; pair, rounded openings posterior on mouth floor.

Variation The other members of the hypodigm are similar to the holophoront in most respects. Variation concerning morphometric measurements is summarized in table 2. The dorsal colour of specimen MNHN 1938.0002 is different as this specimen is not more or less uniformly dark brown with indistinct darker spots near warts, but lighter brown with distinct dark brown patches including a band between the eyes. Six out of seven specimens show elongate fine warts either on lateral part of back or all over back.

Table 3 Principal component analysis using marivax rotation with Kaiser normalization of factor loadings for adult males of *Quasipaa courtoisi*, *Q. exilispinosa*, *Q. jiulongensis*, *Q. spinosa* and *Q. acanthophora*

A Total variance explained

PC	Initial eigenvalues			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	7.908	34.382	34.382	5.609	24.388	24.388
2	4.262	18.531	52.913	5.090	22.131	46.519
3	2.651	11.524	64.437	3.513	15.273	61.792
4	1.713	7.448	71.885	2.063	8.968	70.760
5	1.041	4.527	76.412	1.300	5.652	76.412

B Rotated component matrix

	Component						Component				
	1	2	3	4	5		1	2	3	4	5
SVL	-0.676	-0.151	0.294	-0.506	0.163	SVL	-0.676	-0.151	0.294	-0.506	0.163
RHW	0.063	0.790	-0.077	-0.289	0.319	RIN	0.428	-0.152	0.271	0.711	-0.058
RHL	0.404	0.804	-0.025	0.236	0.054	REN	-0.045	0.362	0.012	0.057	0.754
RTL	0.729	0.233	0.046	0.215	0.091	REL	0.507	0.569	-0.185	0.244	-0.184
RMN	0.300	0.893	-0.035	0.193	0.106	RTEL	0.747	0.177	0.219	0.117	-0.083
RMFE	0.260	0.891	-0.080	0.100	-0.040	RFTL	0.878	0.191	0.152	-0.006	-0.087
RMBL	-0.137	0.906	-0.025	-0.115	-0.070	RIMT	-0.105	-0.296	0.280	-0.100	0.648
RIFE	0.227	0.532	0.258	-0.037	-0.095	RITL	0.802	0.040	0.220	-0.030	-0.116
RIBL	0.498	0.517	-0.078	0.381	0.087	RWTF	0.142	0.088	0.876	0.076	-0.045
RLL	0.143	-0.122	-0.217	-0.846	-0.018	RWFF	0.215	-0.220	0.860	-0.007	0.113
RHAL	0.765	0.254	0.055	-0.095	0.052	RWI	0.093	0.068	0.831	0.297	-0.020
REOL	0.927	0.050	0.191	-0.000	0.010	RWII	0.103	-0.049	0.865	0.028	0.233

Comparisons with closely related species The new species displays the following characters that are diagnostic of the genus *Quasipaa* (OHLER & DUBOIS, 2006) first finger longer than second; tarsal fold present, external fold along fifth toe extending to the base of the tarsus of this toe; spines on chest of breeding male as a single group, not separated in two lateral patches. Within this genus, the aspect of the dorsal warts in this species agrees with the informal group "*Quasipaa* sensu stricto", as defined above. We provide multivariate analysis and short pairwise comparisons with the four other species currently recognized in this group.

Principal component analysis including size-corrected measurements of *Quasipaa courtoisi*, *Q. exilispinosa*, *Q. jiulongensis*, *Q. spinosa* and *Q. acanthophora* results in 5 principal components with a loading higher than 1 (tab. 3, fig. 2). They provide a rather good summary of the data, accounting for 76.4 % of the total variance (tab. 3). The first principal component shows a high loading for variables of limbs (HAL, TFL, TL, FOL, FTL, ITL), the second principal component mainly describes head shape, having highest loadings from measurements concerning head width (HW) and head length (HL, MN, MBE, MFE); the third component is dominated by variables describing webbing (WTF, WFF, WI, WII); the fourth component shows high loadings for forelimb length (FLL) and internarial distance (IN), and the fifth for distance of nostril to eye (EN) and length of inner metatarsal tubercle (IMT).

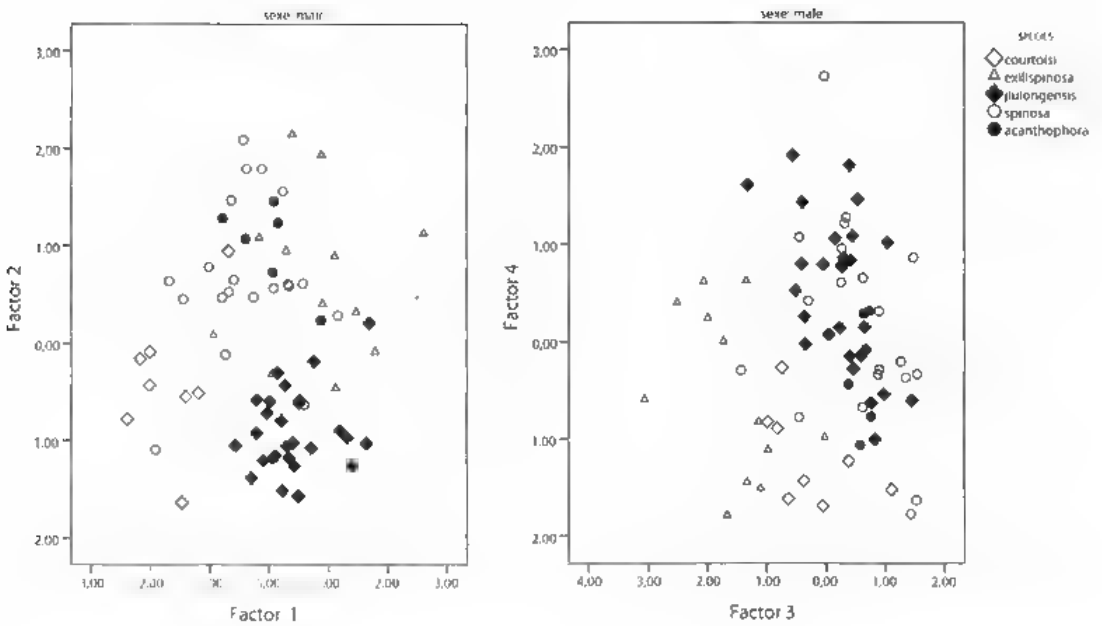

Fig. 2. Results of multivariate morphometric analysis of adult males of *Quasipaa courtoisi*, *Q. exilispinosa*, *Q. julongensis*, *Q. spinosa* and *Q. acanthophora*. Left: plot of principal component factor 1 against factor 2, right: plot of principal component factor 3 against factor 4

ANOVA analysis shows that all these five principal components provide significant discrimination between the five species (tab. 4). Posthoc test shows pairwise significant differences for some of these principal components for all groups studied. PC1 allows significant discrimination of *Q. courtoisi* from all other species and also to discriminate *Q. spinosa* from *Q. exilispinosa* and *Q. julongensis*. PC2 distinguishes *Q. julongensis* from *Q. exilispinosa*, *Q. spinosa* and *Q. acanthophora*, *Q. courtoisi* from *Q. spinosa* and *Q. acanthophora*, and *Q. spinosa* from *Q. julongensis*. PC3 separates *Q. exilispinosa* from all other taxa studied. PC4 shows significant differences between *Q. courtoisi* and *Q. julongensis* and *Q. spinosa*, and between *Q. exilispinosa* and *Q. julongensis*. Thus all species can be discriminated from each other by principal component analysis using morphometric characters, except for the pair composed of *Q. spinosa* and *Q. acanthophora*

The results given above confirm the morphological distinction between *Quasipaa courtoisi* and the other species of *Quasipaa* briefly mentioned, but not documented, by Ohler & Dubois (2006). PC1 allows discriminating *Q. courtoisi* from the other species of this group by lower values of the ratios to SVL of measurements which concern mainly the hands (HAL, TFL), tibia (TL) and feet (FOL, FTL, ITL). PC2 distinguishes this species from *Q. julongensis*, *Q. spinosa* and *Q. acanthophora* by ratios to SVL of measurements which concern the head: width (HW) and length (HL, MN, MFE, MBE) are smaller in *Q. courtoisi* than in *Q. spinosa* and *Q. acanthophora*. But *Q. julongensis* has larger values for HW and MBE than *Q. courtoisi*. PC3 allows to distinguish *Q. courtoisi* from *Q. exilispinosa* by ratios concerning the webbing (WTF, WFF, WI, WII) which are larger in *Q. courtoisi* than in *Q. exilispinosa*

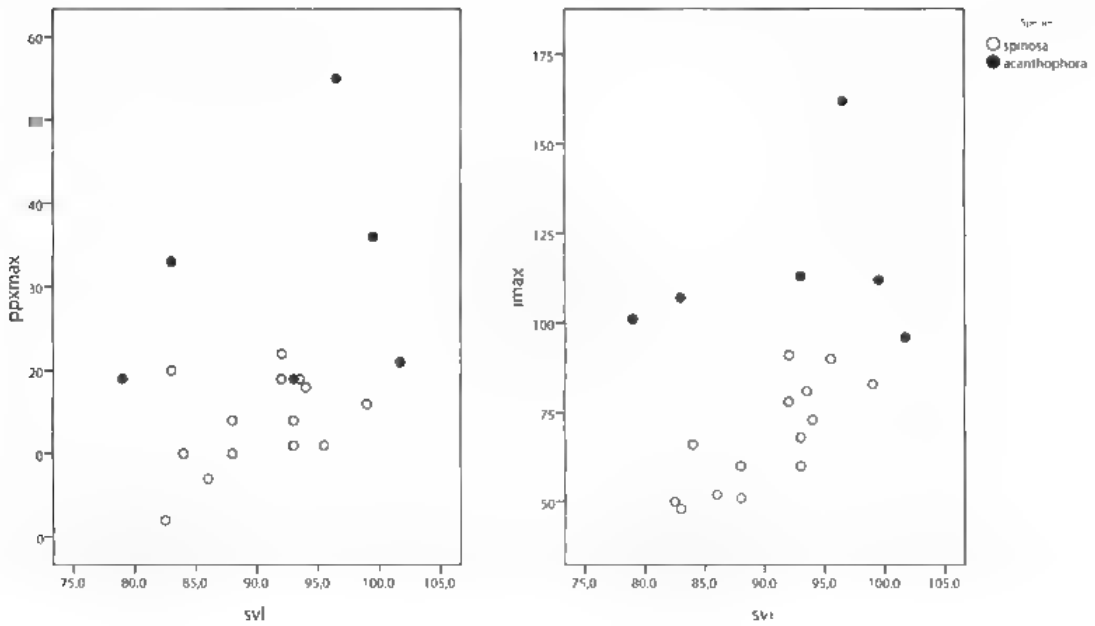

Fig 3 Maximum numbers of nuptial spines present on prepollex (ppxmax) and finger I (imax), relative to snout-vent length (SVL) in adult breeding males of *Quasipaa spinosa* and *Q. acanthophora*. The value used for each specimen is the maximum number of spines displayed in each frog either on the right or on the left hand

PC1 distinguishes the new species from *Q. courtoisi* by larger ratios of SVL of measurements concerning the hand (HAL, TFL), tibia (TL) and feet (FOL, FTL, ITL). PC2 allows distinction of these two species by ratios of SVL of measurements concerning the head (HW, HL, MN, MFE, MBE) which are larger for *Q. acanthophora* than for *Q. courtoisi*. PC3 discriminates the new species from *Q. exilispinosa* by ratios of measurements which concern the webbing (WTF, WFF, WI, WII), which is larger in *Q. acanthophora* than in *Q. exilispinosa*.

The new species must be considered a sibling species of *Quasipaa spinosa* (David, 1875) as it does not differ in any of the morphometrical measurements or ratios. Nevertheless this may be due to the heterogeneity of the sample used in this study and considered to be *Q. spinosa*. This sample includes specimens from various regions of China (see app. 1) that are morphologically variable and which most probably consist of several species. Here we recognize the Vietnamese population as a distinct species as these specimens can be distinguished by sexual characters. In many Paini species, adult males show large black spines on various parts of the forelimbs, chest and sometimes venter. Although within a species the number of spines varies according to age and reproductive stage, in several cases very similar species can be distinguished by the number of spines present in some locations (DUBOIS, 1976; DUBOIS & MATSUI, 1983). Figure 3 shows the numbers of nuptial spines on the prepollex and finger I for specimens of *Q. acanthophora* and *Q. spinosa* of similar body sizes. These numbers are significantly different and the numbers of spines on finger I does not even overlap between the two groups: 14 males of *Q. spinosa* have 48-91 spines, whereas 6 males of *Q. acanthophora* have 96-162 spines. (tab. 1)

Beside these differences in male nuptial spines, *Q. acanthophora* differs from *Q. spinosa* in the aspect of warts on back, which are fine and elongate, whereas they are rounded in *Q. spinosa*. The dorsal warts of *Q. spinosa* bear dark, keratinized spinules. These spinules are absent or small and not keratinized in *Q. acanthophora*. Both species exhibit keratinized spines on the dorsal surface of shanks.

Q. acanthophora can be distinguished from *Q. exilispinosa* by adult size, the latter being much smaller. In the sample of the latter species that we measured (see app. 1), SVL of 13 ♂ ranges from 40.0 to 69.0 (mean 55.9 ± 8.40) and that of 11 ♀ ranges from 48.5 to 64.9 (mean 55.6 ± 4.66). Among our *Q. acanthophora* sample, SVL of 6 ♂ ranges from 79.0 to 101.7 (mean 92.1 ± 9.18) and that of our single ♀ is 81.0 mm. If we consider that all the 14 specimens reported by Bourret (1937) were indeed members of this species (which is quite likely, as all samples of Bourret's amphibian collection in the Paris Museum prove to be monospecific, even if they now bear a different nomen, which suggests that this excellent naturalist had a good "feeling" for species identification), then the extreme values in the Vietnamese species become 89-123 in ♂ and 84-104 in ♀, which shows no overlap with *Q. exilispinosa*. A single ♂ specimen of our sample from Vietnam (BMNH 1903.7.2.26, SVL 61.3 mm) is included in the range of adult males of *Q. exilispinosa*, but, although it shows some spines on prepollex and fingers I and II, it is not yet fully adult, as shown by absence of spines on finger III, so we did not include it in our calculations of tab. I. Beside size, these two species are also distinguished by webbing, which is less extended in *Q. exilispinosa*: significant differences between them exist for all four webbing measurements used in this study. *Q. exilispinosa* can also be distinguished by its much lower number of nuptial spines on fingers and breast.

The new species can be distinguished from *Q. julongensis* by the shape of the head, which is distinctly longer and larger in *Q. acanthophora*. Males of *Q. julongensis* also have significantly smaller numbers of spines on prepollex and fingers I and II.

Finally, the new species differs from *Q. courtoisi* in head shape. The head is distinctly longer in *Q. acanthophora*, which shows more distant nares and eyes. The tibia, foot, toes, hand and fingers are longer in *Q. acanthophora*, and the webbing between toes III and IV is less developed in *Q. courtoisi*.

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Appendix 1

List of specimens examined and measured

Beside the hypodigm of the new species described above, we examined and measured 133 specimens of the four other species here referred to the "*Quasipaa* sensu stricto" group. They are currently or were formerly kept in the following collections: American Museum of Natural History, New York, USA (AMNH); Natural History Museum, London, United Kingdom (BMNH); Chengdu Institute of Biology, Chengdu, China (CIB), Field Museum of Natural History, Chicago, USA (FMNH), Laboratoire de Zoologie de l'Université de Hanoi, Vietnam (LZUH), Museum of Comparative Zoology, Harvard, USA (MCZ); Muséum National d'Histoire Naturelle, Paris, France (MNHN), Zoologisches Museum und Forschungsinstitut Alexander Koenig, Bonn, Germany (ZFMK)

Quasipaa courtoisi (Angel, 1922) China *Anhui Province* Cheki BMNH 1947.2.1 86, MCZ 17458, MNHN 1922 0093, MNHN 1923 0014, MNHN 1923.0016, MNHN 1923 0018-0021, 9 ♂; MNHN 1923.0022-0025, 4 ♀.

Quasipaa exilispinosa (Liu & Hu, 1975) China (A) *Fujian Province* (1) Chungan Xian AMNH 29575-29576, BMNH 1956 1 9 78, 3 ♂, AMNH 28892, 1 ♀, (2) Daiyun Shan CIB 920037, 1 ♂, CIB 920038, 1♀, (3) Kuatin ZFMK 9723, 1 ♂; ZFMK 9726, 1 ♀ (B) *Hong Kong* The Peak BMNH 1956 1 9 79-81, BMNH 1974 2122-2124, MNHN 1988.7892, MNHN 1994.4504, 9 ♂, BMNH 1956 1 9 82, BMNH 1974 2126-2128, MCZ 9423-9424, MNHN 1988 7891, MNHN 1988 7893, 8 ♀

Quasipaa jiulongensis (Huang & Liu, 1985) China *Fujian Province* (1) Chungan Xian AMNH 28894-28895, AMNH 28907, AMNH 28909, AMNH 28913, AMNH 28920, AMNH 28922-28926, AMNH 29655-29656, AMNH 29659, AMNH 29661-29662, AMNH 29668, AMNH 29675, AMNH 29677, AMNH 29679-29681, AMNH 29684, AMNH 29745-29748, 27 ♂; AMNH 28908, AMNH 28910-28912, AMNH 28914-28916, AMNH 29485, AMNH 29660, AMNH 29663-29665, AMNH 29669-29671, AMNH 29673-29674, AMNH 29676, AMNH 29678, AMNH 29749-29750, CIB 641 1962, 22 ♀; (2) Wuyi Shan: CIB 920047, 1 ♀

Quasipaa spinosa (David, 1875) - China (A) *Fujian Province* (1) no locality: AMNH 30824, 1 ♂, (2) Amoy AMNH 44396, 1 ♀, (3) Chungan Xian, AMNH 05410, AMNH 05412, AMNH 28896, AMNH 29198-29199, AMNH 29480-29481, AMNH 29657, AMNH 29667, AMNH 29672, 10 ♂, AMNH 28906, AMNH 29479, AMNH 29482, AMNH 29658, 4 ♀, (4) Futsing Xian AMNH 05414-05415, 2 ♀, (5) Kuatin BMNH 1899 4 24 68, ZFMK 9712, ZFMK 9728, 3 ♂, ZFMK 9724, 1 ♀, (6) Pingho BMNH 1907 10 30 3, 1 ♀, (7) Yenping AMNH 18457, AMNH 28173-28174, AMNH 28177, 4 ♂, AMNH 08082, AMNH 18450, AMNH 18453-18454, AMNH 28172, AMNH 28175-28176, 7 ♀ (B) *Guangdong*

Province (1) no locality BMNH 1926.10.27.1, AMNH 24314, 2 ♂, AMNH 24315, BMNH 1926.10.27.2, 2 ♀, (2) Lo Fau MCZ 11756, 1 ♂, MCZ 11757, 1 ♀. (C) *Hunan Province*: Yizhang: CIB 75.I.006, CIB 75.I.011, 2 ♂ (D) *Jiangxi Province*: Pinghsiang AMNH 00669, 1 ♂, ZFMK 9749, 1 ♀ (E) *Zhejiang Province*: Ningpo: BMNH 1854.2.10.39, 1 ♀.

APPENDIX 2

LIST AND DESCRIPTION OF MEASUREMENTS TAKEN ON SPECIMENS STUDIED

Body. – SVL, snout vent length

Head. – EL, eye length; EN, distance from anterior corner of eye to nostril; HL, head length (from posterior corner of mandible to tip of snout), HW, head width, at the angle of jaws; IBE, distance between posterior corners of eyes, IFE, distance between anterior corner of eyes, IN, internarial distance, IUE, minimum distance between upper eyelids; MBE, distance from posterior corner of mandible to posterior corner of eye, MFE, distance from posterior corner of mandible to anterior corner of eye; MN, distance from posterior corner of mandible to nostril; NS, distance from nostril to tip of snout, SL, distance from anterior corner of eye to tip of snout, TYD, maximum tympanum diameter; TYE, distance between tympanum and posterior corner of eye; UEW, maximum width of upper eyelid

Forelimb FLL, forelimb length (from elbow to base of outer palmar tubercle), HAL, hand length (from base of outer palmar tubercle to tip of third finger); TFL, third finger length (from base of first subarticular tubercle)

Hindlimb FL, femur length (from vent to knee); FOL, foot length (from base of inner metatarsal tubercle to tip of fourth toe); FTL, fourth toe length (from base of first subarticular tubercle to tip of fourth toe), IMT, length of inner metatarsal tubercle, ITL, inner toe length, TFOL, length of tarsus and foot (from base of tarsus to tip of fourth toe), TL, tibia length, TW, maximum leg width.

Webbing. FFTF, distance from maximum incurvation of web between fourth and fifth toe to tip of fourth toe, toes being spread, MTTF, distance from distal edge of metatarsal tubercle to maximum incurvation of web between third and fourth toe, toes being spread, MTFF, distance from distal edge of metatarsal tubercle to maximum incurvation of web between fourth and fifth toe, toes being spread, TFTF, distance from maximum incurvation of web between third and fourth toe to tip of fourth toe, toes being spread.